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*Sitnikova M.A.***THE PSYCHOLOGICAL ASPECTS
OF LEFT-HANDEDNESS
AND SINISTRALITY AMONG
SCHOOLCHILDREN****ABSTRACT**

Nowadays, there are many schoolchildren who demonstrate a large number of left-sided motor and sensory preferences. It can be considered as external markers of functional hemispheric asymmetry of the brain. The main purpose of the study is to investigate psychological peculiarities and specificity of age-related dynamics of laterality pattern's formation in junior schoolchildren.

The findings show that left-handers differ greatly from right-handed schoolchildren in their mental development by having some peculiarities of intelligence, world's perception and prevailing thinking strategies, ways of memorization, specificity of emotional-affective expression. As a result they have some educational peculiarities and difficulties. The main problems of left-handed children in school performance are academic failure, lack of perseverance, anxiety neurosis, and extreme emotional lability.

Integrated development of left and right hemispheres of left-handed schoolchildren is a favorable condition for their harmonious personal and intellectual development and effective mastering of various modules of the school curriculum. The technological solution of the problem of teaching the children with left-sided laterality is to include in educational programs some special exercises to develop imagination, emotional sensitivity, integrity of perception, global view to the problems, creativeness, and original approaches to tasks' solving.

Keywords: functional asymmetry of the brain; laterality profile; left-handedness; sinistrality; neuro-psychology of childhood.

*Ситникова М. А.***ПСИХОЛОГИЧЕСКИЕ АСПЕКТЫ
ЛЕВШЕСТВА И ЛЕВОРУКОСТИ
У ШКОЛЬНИКОВ****Аннотация**

На современном этапе развития общества многие школьники демонстрируют большое количество левосторонних моторных и сенсорных предпочтений. Эти показатели могут рассматриваться как внешние маркеры функциональной межполушарной асимметрии мозга. Основной целью исследования является изучение психологических особенностей и специфики возрастной динамики становления профиля латеральных предпочтений у младших школьников.

Результаты исследования показывают, что левши значительно отличаются по своему психическому развитию от праворуких школьников своеобразием восприятия окружающей действительности, запоминания, преобладающими стратегиями мышления, спецификой аффективно-эмоциональных проявлений. Вследствие этого у левшей отмечаются некоторые особенности и сложности в традиционном образовательном процессе. К основным проблемам левшей в рамках школьного обучения относятся академическая неуспеваемость, неусидчивость, неврозы, проявления чрезмерной эмоциональной лабильности.

Интегрированное развитие правого и левого полушарий у леворуких школьников рассматривается как благоприятное условие для их гармоничного личностного и интеллектуального развития и эффективного освоения различных модулей школьной программы. Технологическое решение проблемы обучения левшей предполагает включение в образовательные программы специальных занятий, направленных на развитие воображения, эмоциональной чувствительности, целостности восприятия, креативности и нетрадиционных подходов к решению различных проблем.

Ключевые слова: функциональная асимметрия мозга, профиль латеральности, левшество, леворукость, нейропсихология детского возраста.

1. Introduction

Functional asymmetry of the brain is one of the most important peculiarities of personality and it operates as one of the factors that determine the psycho-physiological adjustment mechanisms of a person, features of development of cognitive, regulatory and volitional spheres [1; 4; 5]. The problem of functional asymmetry of the brain (FAB) is currently being investigated within differential neuropsychology [6; 7] and neuropsychology of childhood [4]. The nature and dynamics of forming the functional organization of the brain are related to the causal level that defines the specificity of a personality's psychological development along with neurobiological features of development and social situation of development [2; 3].

The human brain works as a paired organ when controlling any mental function. It defines the functional hemisphere specialization. Both hemispheres are involved in the process of implementation of any mental function, but either right or left hemisphere can be the leading one. This indicates the existence of specific bilateral principle of implementing such important brain functions as perception, attention, memory, thinking, speech [2]. So every person in human population has the dominant cerebral hemisphere regulating the interaction with the environment. But brain hemispheres function as a unit as they are connected by cerebral commissures. More than 90% of motor and sensory functions are controlled by the opposite hemisphere of the brain. The left hemisphere controls the right hand, foot, ear and eye. The right hemisphere controls the left hand, foot, ear and eye.

2. Concept and main causes of left-handedness and sinistrality

Sinistrality – is a complex stable psychophysiological characteristic, a specific type of functional organization of the brain. Sinistrality, as well as dextrality, can be absolute and partial. There is only 42% of the European population that is absolute dextral. They demonstrate all right-sided motor and sensory preferences. Absolute lefties demonstrate all left-sided preferences. They are only 8-10% of the population. The majority of people (48% - 50%) is partial sinistral or dextral.

Left-handedness reflects the preference of active using of the left hand. Moreover there can be left-footedness, left-ear and left-eye preferences. As for left-handedness it is much easier for other people to notice a person who uses the left hand while writing, eating, sewing and drawing than to learn his or her eye or foot preferences.

There are four main types of handedness [7]. Right-handedness is most common. Right-handed people are more dexterous with their right hand when performing a task. A variety of studies suggest that 70-90% of the world population is right-handed.

Left-handedness is less common than right-handedness. Left-handed people are more dexterous with their left hand when performing a task. A variety of studies suggest that 8–12% of the world population is left-handed.

Mixed-handedness, also known as cross-dominance, provides doing different tasks better with different hands. For example, mixed-handed persons might write better with their left hand but throw a ball more efficiently with their right hand.

Ambidexterity is very rare, although it can be found. A true ambidextrous person is able to do any task equally well with both hands.

The fundamental problem when discussing left-handedness and sinistrality is to determine the cause. No one knows exactly why almost 90% of human population is right-dominant and only 10-12% of people demonstrate left-sided laterality but a number of theories have been proposed. So there is no single cause of left-handedness. There are genetic and pre- and postnatal conditions that can result left-handedness.

Approximately 25% of all left-handers are natural or genetic lefties. Inheritance plays a leading role here. If both parents are right-handed, the probability of having a left-handed baby is about 2%. If one of the parents is left-handed, the probability increases to 17%. If both parents are lefties, so they would have a child with left-sided laterality in almost 46% of cases [5].

In the right shift theory handedness is explained by the presence or absence of a specific gene [8]. They consider that there is the right shift's gene. But in 2007 researchers discovered a gene LRRTM1. This is the first gene that potentially increases the likelihood of a person having

left-handedness. Unfortunately, even presence of this gene does not automatically guarantee a left-handed baby.

The Geschwind theory states that the presence of high levels of testosterone before birth can lead to a left-handed child [11]. There is the strong evidence that prenatal testosterone contributes to brain organization. High level of prenatal testosterone results in a higher incidence of left-handedness. Testosterone suppresses the growth of the left cerebral hemisphere and so more neurons migrate to the right hemisphere. The highly developed right hemisphere is better suited now to function as the center of language and handedness. The fetus is more likely to become left-handed since the right hemisphere controls the left half of the body. Perhaps this explains why there are more left-handed males than females.

The pathological or compensatory left-handedness can be due to the brain damage during the birth process or the brain dysfunction that can occur in prenatal or natal period. Difficult or stressful birth, accelerated or delayed delivery, birth trauma happen far more commonly among babies who grow up to be left-handed or ambidextrous. Also it may be the result of prematurity, dystocia, a new-born baby's asphyxia, severe disease and traumas in infancy [9; 6].

The most common causes of forced or learned left-handedness are considered as a long-term injury of the right hand, congenital abnormality or the loss of the right upper limb. If the dominant right hand is damaged at the age when a child only starts learning various manipulations by hands, he or she tries to protect the limb and learn to use actively the left one. Sometimes left-handedness can be the result of social learning. Children can imitate their relatives' hand preferences or choose consciously left-sided laterality to look like them.

Functional asymmetry of the brain can change from the birth until the age of 18. In the early stages of ontogeny most children demonstrate right-hemisphere type of world's perception as the right hemisphere is maturing faster than the left one. In early postnatal period any individual has already prerequisites for functional asymmetry of the brain, but no type of functional asymmetry has formed yet. The basis of

functional hemisphere specialization is inborn; but development, improvement and complication of the interhemispheric asymmetry's and interhemispheric interaction's mechanisms take place during child's growing up.

According to statistics, there are less lefties among adults than among children. The percentage of left-handers decreases greatly as they grow older. Even among children there is no constant number of left-handers. There is a tendency: the younger the children - the higher the percentage of left-handers among them. From the birth till the age of 3 the number of right-handers increases from 50% to 80% and by the age of 10 this number is up to 88% - 90%. Small children show the left-sided laterality more often but it does not mean true ambidexterity or sinistrality and it does not reflect the peculiarity interhemispheric interactions' formation [3; 5]. Significant changes in interspheric interaction are observed in the first stage of schooling when the lateralization of brain functions occurs.

Functional asymmetry of the brain has also a bio-social dependence. The right shift theory of handedness postulates that left cerebral hemisphere dominance can be regarded as the biological function of growing up, on the one hand, and as the result of cultural traditions, social influences and learning techniques, on the other hand [1; 9; 10].

3. Peculiarities of lefties and left-handed schoolchildren

Nowadays there is a significant increase of the incidence of ambidexterity and sinistrality among children, who demonstrate a large number of left-sided motor and sensory preferences which are considered as external markers of functional hemispheric asymmetry of the brain. The analysis of mental differences of schoolchildren from the standpoint of a complex neuro-bio-social nature of personality development and ontogenetic peculiarities of the laterality pattern can be regarded as the real condition of rendering effective assistance to left-handed schoolchildren, predicting their success or failure in school performance. The category of left-handed schoolchildren is heterogeneous and little-studied. When compared with right-handers left-handed children differ greatly in mental development by having some peculiarities of intelligence, world's

perception and prevailing thinking strategies, ways of memorization, specificity of emotional-affective expression.

Left-handedness and sinistrality as a variant of normal personality development are determined by the dominance of the right hemisphere of the brain. The right cerebral hemisphere is characterized by synthetical character of mental processes, dominance of intuition, simultaneous processing of large amount of information in the form of images. This hemisphere of the brain determines the spatial-imaginative, intuitive, three-dimensional way of thinking that creates a lively and integral image of the world, reflecting its diversity and complexity [9; 10].

In modern society there was a positive shift towards the recognition of left-handed children's special educational needs and opportunities. Moreover nowadays they refuse to retrain left-handers. However every day left-handed schoolchildren, living in a world dominated by right-handed people, face many challenges and frustration – the so called “dextral-stress”. During the period of adaptation to the school system left-handers are in a situation of a double stress. As a result of constant failures experienced by the children, they are not confident in their abilities, anxious, depressed and dissatisfied.

Moreover children are developed at different rates, and some children show no strong preference for one hand over the other one to write with by the age of 5. In left-handers it is common for this preference to be delayed up to the age of 7. According to the modern educational programs children start to learn writing skills at 5, if not younger, and all children are urged to choose a hand for writing at this age. A child without a strong hand preference can therefore be at an even greater disadvantage than a strongly left-hand biased child. That is because sometimes children may begin writing with one hand then want to switch to the other as their hand-eye co-ordination and fine motor skills develop. As a result the main problems of left-handed children at the primary school age are academic failure, lack of perseverance, anxiety neurosis and extreme emotional lability [3; 6; 7; 12].

The problem statement shows that understanding and investigating of left-handers' dif-

ficulties while studying at school is topical and relevant nowadays. One must pay special attention to the lateral profile (LP) in the complex psychological diagnosis, which is considered to be one of the factors that determine possible difficulties of left-handers while mastering various modules of the school curriculum. Integrated development of the left hemisphere and the right hemisphere of the brain is a favorable condition for harmonious personal and intellectual development of schoolchildren.

4. Method of investigation

Currently there are several classifications of functional asymmetry of the brain in neuropsychology. In Russia the most popular complex classification is based on the analysis of interhemispheric interaction according to three sensory receptor systems (“hand-ear-eye”) [6]. Theoretically there can be identified 27 variant of lateral profiles according to three types of functional asymmetry: manual, visual, audile. But for practical purposes these lateral profiles can be integrated into 5 main groups (where R means right-sided preferences of any paired organ, A – active usage of both hands, ears or eyes, L – left-sided preferences of any paired organ):

- dextrals who demonstrate right-sided dominance in all sensory receptor systems (right hand – right ear – right eye (RRR));

- right-handers who have right-hand dominance combined with different variants of ear and eye dominance (RRL, RAR, RAA, RAL, RLA, RRL, RLR, RLL);

- ambidexters who use both hands as active and can have different variants of ear and eye dominance (AAA, ARR, ARA, AAR, ARL, ALR, AAL, ALA, ALL);

- left-handers who have right-hand dominance combined with different variants of ear and eye dominance (LRR, LRL, LLR, LRA, LAR, LLA, LAL, LAA);

- sinistrals who demonstrate left-sided dominance in all sensory receptor systems (left hand – left ear – left eye (LLL)).

These classifications were the basis for the complex of techniques used in the study to investigate the laterality pattern among primary school children. The diagnostics of laterality profile identifies the type of interhemispheric asymmetry of the brain and determines the de-

gree of left-handedness. The choice of tests was determined by the age peculiarities of schoolchildren. Some genetic and social aspects of interhemispheric asymmetry of the brain were taken into account. The procedure can be carried out frontal; it is technically uncomplicated and doesn't take much time. All tests in the complex of techniques can be done individually and in any sequence.

The complex of techniques includes practical test to find out motor (the leading hand, foot), sensory (the leading eye, ear) and cognitive (dominant hemisphere) asymmetries. But the fundamental part of this complex diagnostics is tests to determine handedness. Handedness is the most studied manifestation of interhemispheric asymmetry.

The system of practical tests to measure the laterality profile includes observation of the children doing various tasks:

- “maps of lateral signs” [9].that take into account both the data of Annett questionnaire and such tests as interlocking fingers, crossing hands on chest, crossing shins and feet, type of applauding, “knee on knee” test, leading ear when “talking on the phone”, leading eye in the “card with a hole” test.
- the system of tests (by M. Osiense) [3], which include practical tasks, such as pricking beads onto a string, threading a needle, pouring water from one vessel to another, striking a match, etc. The activities proposed in practical tasks are neither everyday nor familiar to children. They require precision, good coordination of movements, agility, which provides a reliable picture of hand dominance.
- the tests include two groups of tasks: “main” tasks, i.e. the activities that are almost always under adult's supervision (for example, a hand to hold a spoon, a pen, a pair of scissors); and “additional” tasks, i.e. the activities which are seldom paid specifically attention to (a hand to lift a toy from the floor, to shake the crumbs from the table, to wave goodbye) (by O.B. Inshakova) [5].

Thus the age-related dynamics and the peculiarities of laterality profile among primary schoolchildren were investigated in the research.

A total of 157 schoolchildren of both sexes at the age of 7 - 10 from the first - fourth forms were

involved in this research. A qualitative analysis of the most common school problems was carried out by using interview and standardized observation. The statistical processing of results was performed with multifunctional Fisher's test.

5. Results and discussions

The findings show that there is a statistically reliable ($f^* = 2,041$, $p < 0,05$) reduction of the number of schoolchildren with left-sided dominance up to the age of 10. 27 children at the age of 7-8 (total number is 75 respondents) demonstrated left-sided preference doing various tasks which are 37% of the total number of children. 48 respondents (63% of subjects) demonstrated right-sided preference when performing practical tests. It was revealed that 13 children aged 9-10 (total number is 82 respondents) belong to the category of schoolchildren who demonstrate left-sided laterality so the percentage of lefties at this age group is only 17% of the subjects. 69 children belong to the category of schoolchildren with right-sided laterality which is 83% of the total number of children[12].

A significant number of lefties and left-handers aged 7-8 indicates the imperfection of cross-functional interactions of the brain's hemispheres at this age stage in accordance with normative formation of progressive lateralization. Whereas a steady decline of the number of left-handed children up to 9-10 years reflects the peculiarities of the formation of spatial and functional organization of the brain systems that show the formation of laterality pattern.

The gender analysis of the laterality profile among schoolchildren showed that at the age of 7-8 67% of boys, that are 18 respondents, and 33 % of girls, that are 9 respondents, belong to the category of lefties (total number is 27 children). At the age of 9-10 left-handed boys also prevail in this category (9 respondents, 72% of total number). So this category includes only 4 girls which are 28% of subjects. Thus, the boys who demonstrate left-sided motor and sensory preferences are predominantly more numerous than the girls in both age groups. This confirms the average statistical data that there are more left-handed males than females.

On the whole, the specificity of the dynamics of left-handedness's manifestation in different age groups was identified. The specificity is re-

vealed in the reduction of the number of ambidexters and children with marked left-handedness and in the increase of the number of schoolchildren with non-marked left-handedness to the age of 10. This is due to the normative formation of progressive lateralization as a reflection of the gradual fixation of the hierarchy of intra- and interhemispheric interactions of the brain.

The qualitative analysis of lefties' educational peculiarities showed that the left-handers may have some problems with understanding and analyzing different situations, may have insufficient vocabulary, may be worse at mastering the skills of reading and writing, but they often have better mathematical abilities than right-handers. When mastering some learning activities at junior school age, the left-handers usually have a number of difficulties concerning insufficient formation of visual-spatial representations, disorders or underdevelopment of fine motor skills and of finger movements' coordination.

The dominance of the right hemisphere determines the sensibility to creativity as well as concrete-imaginative character of cognitive processes. To remember new and unknown information "right-hemispheric" children rely on their visual and tactile sensations and they need the support of a figure, a natural object or any other adjuvant. Left-handers are sensitive to tiny changes in color or shape of any object; they individualize the world and the society.

Left-handed children are typically more vulnerable, emotional, lively and anxious; they get accustomed to a changing situation less successfully. Sometimes they can be too much open to other people, naïve, unreasoned in expression of their feelings and suggestible. Right hemisphere dominant children are inclined to meditativeness and reminiscence, they feel and perceive all events in their life subtly and deeply. Often they behave under the influence of momentary mood; they are easily upset; anyone can easily make them cry or angry.

Many of them are slow in drawing, writing and other manual activities, but, conversely, hyperactive in free activity. So slowness in carrying out fine coordinated movements can be combined with general motor disinhibition. The left-handers are also characterized by inconsistency of their psycho-emotional sphere: com-

munication need – shyness, dominance need – conformity, recognition and esteem needs – low self-control of behavior.

They can learn social norms and rules quickly and firmly. It defines their responsibility, commitment and sociability but it is often combined with the lack of self-confidence. It's difficult for left-handed children to work in large groups with strictly regulated conditions and subordination. They prefer individual work where they can demonstrate their own initiative and intuition, creativeness and rich imagination or fantasy.

The main problems and difficulties of left-handed children at primary school are:

- academic failure in learning to read and write, in visual-motor coordination, in visual memory, in space, time and plane orientation;
- lack of perseverance, unreasonable anxiety, problems with attention focusing and substance memorization;
- extreme emotional lability, fluctuations of mood;
- lack of self-confidence, the persistent feeling of loneliness, touchiness;
- fear of silence or, on the contrary, painful reaction to any noise;
- irritability, impatience, hastiness, low self-control.

In modern educational technologies teachers train and develop only left hemisphere of the brain and logical thinking overvaluing their role in the capacity of intellectual activity of children and ignoring thereby half of the brain power. But at the first stage of school education the main type of thought is representational which involves the right hemisphere in the process of learning. To intensify the effectiveness of educational technologies it is necessary to put into practice such special features of the right hemisphere of the brain as imagery, generality, integrity, emotionality of perception and involuntariness as often as possible.

Thus, there is the importance to integrate the lateral profile in the complex psychological assessment of schoolchildren and in the complex psychological diagnosis to predict their possible success or failure in school activities. Nowadays there is a lack of adjustment and remedial school activities to stimulate the intensive development of the children' right hemisphere.

The main art-technologies include: dough modeling; drawing therapy and art-design; making foil dolls; fairy-tale therapy; dance therapy; body-oriented therapy; role-playing therapy; trainings; psychodrama. Dough modeling involves making figurines of humans, animals and various objects (vases, boxes), pictures out of salty dough. All these can later be painted with gouache. It is also possible to combine dough with other materials: peas, beans, twigs, small sticks, beads etc.

Art-design uses color-psychology, inkblot psychology. Some special artistic techniques can be applied for remedial and developing aims. For example, children are invited to finish a picture having only two or three lines or figures, making it meaningful. Stencil drawing involves filling in contours of animals, humans, machinery models with letters, numbers, geometric figures or their elements, and making a human being, for example, with the help of fruits, or a car - of flowers. The technique of making a foil doll allows children to develop creative expression and to represent self-image. It enables a visual projection: understanding of feelings, experience of different emotions through symbolic representation.

Fairytale therapy, role-playing games and psychodrama in the suggested program are used as integrated classes for psychological intervention and development of leadership potential, overcoming anxiety and reducing aggression by means of fairytale plots based on the works of Russian folklore, folk and literary fairytales. Children who are leaders are invited to play the

roles of rejected heroes (outsiders) to correct their leadership potential. Children, who are not leaders, are offered the roles of hero-leaders, both negative and positive to develop leadership qualities. The use of dance and body-oriented therapies includes free dance, mirror dance, "merry animals" dance, "body" drawing and massage with game's elements.

Educational technologies and equipment should be adapted where relevant to give left-handed children an equal learning experience. So the important training aids for the left-handed school children are:

- modified tools for writing;
- three-dimensional aids for the development of spatial thinking;
- visual aids such as pictures, schemes, special educational signs and sketches;
- methods and techniques of teaching based on kinetic memory;
- exercises and plays aimed at prevention and elimination of difficulties in interpersonal relationship and communication with other children.

In conclusion, psychologists and teachers are to take into consideration the peculiarities of lateral profiles of schoolchildren. Some special activities and exercises to develop both right and left hemispheres of the brain should be included into educational programs. Education of lefties and schoolchildren who demonstrate left-sided preferences should contain elements of adaptation and include specially organized remedial and developing classes.

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